no matter what their station in life, with equal courtesy, and a clear, sound judgment, which guarded him from the imposition of the fraudulent or the flattery of the interested. To use the expression of one who knew him long and well, Mr. Charlemagne Tower, Jr., "the leading traits of his private character were honor and loyalty." His charities were unostentatious, but large and constant. One of his old friends writes me that he personally knows of several whom Mr. Keim regularly assisted, and who depended on this assistance for much of the comfort of their lives.

While his acquaintances were numbered by thousands, his intimates were few. Although affable and ready of access, it was not at all easy to understand his real nature, nor to approach his inner personality. A peculiar dry humor, an odd candor of expression, foiled the importunate and disarmed the aggressive. Under the appearance of a certain levity of language and manner he baffled those who attempted to transgress the lines which he had drawn around his intimate life. The impression thus created was so different from that usually expected from a man bearing such heavy burdens of responsibility, that it always at first puzzled, if it did not even disappoint, those who knew him but slightly. Behind this outward habit of encounter, however, was a keen, penetrating judgment and a warm, sympathetic nature, fully recognized and appreciated by those who understood the thoroughness of his work and the spirit of his actions. By his death our city lost a distinguished and worthy citizen, his friends one always dear to them, and this Society an estimable and interested member.

Some New Red Horizons.

By Benjamin Smith Lyman.

(*Read before the American Philosophical Society, May 18, 1894.*)

It seems to be worth while to give, at least roughly and in part conjecturally, some idea of the relative geological position of the different horizons from which fossils have been reported in the so-called American New Red of the eastern part of the United States; for it will thereby be seen how completely and naturally the recently discovered, unexpectedly great, and consequently perhaps not readily accepted, thickness of the New Red in Montgomery county, Pa., harmonizes with all the hitherto

publicly recorded facts in other States. It is true the imperfection of the records will make the present attempt somewhat conjectural, but there is reason to hope that it may keep well within the not wholly unprecedented New Red proportions of two bushels of conjectures to two grains of fully ascertained facts.

Indeed, a great share of what has been voluminously written about the New Red is a mere tissue of conjectures, one part depending on another; but if their connection be traced from one to another it will be clear that the starting-point or original support of them all is the supposed fact superficially and inaccurately observed, and in any case not necessarily conclusive, that the beds in question were at the outset wholly, or almost wholly, of a red color. To be sure, dark-colored beds were seen here and there, but were supposed to have become so by the baking of neighboring exposed or subterranean trap. They were sometimes called "indurated shales," though miles away from any visible trap, and their existence above trap beds, even at some distance, was considered by the most skeptical to be sufficient proof of the intrusive character of the trap.

The next conjecture was that as the beds were all red, or originally so, they must be of one narrow paleontological period, a conjecture favored by the circumstance that fossils were not very numerous, and in fact, as we shall presently see, were confined in great measure to a very limited portion of the whole series. They were all referred indiscriminately to the series merely as a whole, and any diversity of character was overlooked or violently disregarded, and they were by circular reasoning pronounced incapable of belonging to species foreign to that small period. Then it was conjectured that during one narrow paleontological period no very enormous thickness of beds could possibly have accumulated, not more than, say, 3000 or 5000 feet. Then, again, it was conjectured that a series of, at the most, such moderate thickness might well exist in full extent within very small geographical bounds, that in short it was, as has been said of the soul in the human body, "all in every part," and was equally complete in Massachusetts, Connecticut, New Jersey, Pennsylvania and in the Richmond (Va.) coal field. The result of borings in that field occasioned the conjecture that the whole New Red series was only 1500 feet in thickness, even in Pennsylvania; and there was probably surprise at finding a boring could be 3000 feet deep without reaching the bottom of the series at Northampton, Mass., where an unprejudiced tyro in geometry might have predicted the result as not improbable from the exposed dips. The idea, however, had by frequent repetition become fixed, though in reality a mere conjecture, that the total thickness must be small, and hence came the unhesitating rejection of the apparent thickness of 14,000 feet in New Jersey and 55,000 feet in Pennsylvania, in spite of their being in truth arrived at by the only means based on published facts then possible, namely, the estimated average dip and the whole geographical breadth of the series. Although, then, the estimates of the total thickness have varied from 1500 to 55,000 feet with some slight support from

observed facts, it has become a heresy to maintain a thickness different from the still more purely conjectural one of between 3000 and 5000 feet.

Then naturally followed conjectures to account with that moderate thickness for so great a geographical breadth in spite of the known dips. These conjectures have been ingenious and elaborately argued and zealously adhered to, but have one by one been disproved or found to be at best only imperfectly supported by observation. It was thought that the dips might be merely apparent or due to false bedding, deposition on a sloping surface, but the thin-leaved, shaly character of some of the beds and the position of the pebbles, ripple marks and fossil footprints have shown the impossibility of that supposition. It was further conjectured that a series of great parallel longitudinal faults with downthrow constantly in one direction might diminish the thickness to the required extent, but their main support was the very insufficient one that recurring hard beds or parallel hills had a similar red color. A careful consideration of the very much curved strike of the beds in some parts of Pennsylvania and New Jersey shows that no series of parallel great faults would help the matter. Besides, although faults of a few feet or yards are numerous, their direction is not generally longitudinal nor the downthrow uniformly in one direction, and but one great fault has yet been proved to exist, and that only in Pennsylvania and New Jersey, and by no means generally longitudinal.

Conjectures in regard to the trap, supposed to be so important in "indurating" and darkening the New Red, have been, if possible, even more wild and needless. The impression seems generally to have been very strong that every mass of trap must be a dike, and that if it was undeniably interbedded conformably with the shales, it must necessarily be a dike that closely followed the bedding intrusively, no matter how many miles, no matter how soft the shales, no matter how gentle the dip. Sometimes it was preposterously suggested that the trap had occasioned the dip of the shales, both near to it and far away. But, in general, as much advantage as possible was taken of the dip, and the trap supposed to be intruded after the dip had been fully acquired, quite dissociating certain sheets of trap from the age of the New Red sedimentary beds with which all the trap is otherwise so closely connected, and not considering that the dip is even now probably still in process of gradual acquirement, or by occasional small fits and starts (witness the earthquake that was felt only the other day between Lambertville and Flemington, N. J., near the line of the great fault there, and corroborative of the existence of the fault at the place pointed out in a former communication, *Proc. Amer. Philos. Soc.*, Vol. xxxi, p. 314). Yet, as the dip alone is so gentle that a dike following it must have come from many miles' distance to have originated at a depth great enough to be melted, and could hardly be supposed to refrain for so long a space from sometimes breaking across the soft shales by a short cut to the surface, it was imagined that the dike must be nearly vertical at a short distance below the outcrop. Then as

the outcrop was sometimes (for example, in the case of the Palisade trap) more than fifty miles long and "as crooked as a ram's horn," the vertical parts of the dike must, by a marvelous coincidence, have followed the same curves. *Credat Judæus Apella, non ego!* Really, such a belief seems to require an amount of credulity hardly consistent with the modern scientific spirit that hesitates to accept extraordinary explanations where ordinary ones can be found to answer the purpose.

The intrusive conjecture has in fact been in great part rejected, but not hitherto for the Palisade trap, owing to certain observed facts. Still, it seems not at all impossible to account for them, so far as recorded, much more easily and naturally than by the well-nigh supernatural intrusive theory. If the trap appears in one place to cross the sedimentary beds on one side, why may it not be either the side of a dike (for, of course, every overflow must come from a dike somewhere) or merely an evidence of the erosion that took place before the trap overflowed; just as in the case of the "horsebacks" or "rock faults" in coal mines, a small valley in the original coal marsh has been filled with sand or silt? If there be here and there a branch from the bottom of the trap sheet running a short distance into the sedimentary beds, is it not as easily conceivable in the case of an overflow as in that of intrusion? Is it wholly inconceivable that apparently similar branches from the upper surface of a trap overflow sheet into the sedimentary beds might sometimes occur, though none are positively recorded? If there be "indurated shales" above some of the Palisade trap, is it not quite possible, in case of real "induration," that there be another overlying unexposed bed of trap that may have caused it, especially as there is other evidence of interbedded shales? The intrusion conjecture is beset with so many serious difficulties, and the overflow theory with so few, the choice between them seems easy. A vast amount of ingenuity has been expended in trying to reconcile observed facts with the intrusive theory, while immensely less skill is required to show the consistency of the facts with the overflow principle.

The New Red theory, with its conjectures and arguments, both for the trap and the sediments, might well be called the tennis ball of American geologists, or a domestic appliance for mental gymnastics, requiring the minimum of work in the field. Nevertheless the fabric, composed, as we have just seen, in the main wholly of conjectures, based one upon another, without having at the bottom one single substantiated fact, has with the lapse of time become so consolidated, and in its older parts, dating from the early infancy of geology in America, has become so venerated that it may now be considered to be a fully "accepted fable." The hand that attempts to disturb it may probably be regarded as sacrilegious; and arguments against it, though thoroughly founded on facts, will be looked on with more suspicion than new conjectures would be if only consonant with the old baseless ones. But however stubbornly skeptical the public may be in refusing to put faith in the present conjectures, well supported by many observations, instead of the old ones, supported only

by other conjectures, there may yet be found some convenience in the present collation of facts.

New conjectures are still necessary owing to the imperfection of the record of facts outside of Pennsylvania. Although the New Red stretches for hundreds of miles close past some of the most populous parts of America, the probable economic resources never seemed enough to secure its thorough examination and a publication of the results. Even as regards field work it has been a sort of play-ground for geologists rather than a place for thoroughgoing investigation. The State governments to this day, with all their surveys, have never fully provided the means for such work. What little field work has been done, outside of Pennsylvania, has been, in great part, carried out with the exaggerated idea that the geology of a region can be studied out merely by a comparison of the fossils, a far shorter and easier way than the laborious methods of properly geological observation and collation. Such purely paleontological geologizing may be likened at its very best to the rapid hypsometrical work of the aneroid instead of the spirit level; and exclusive dependence on the fossils for geological indications may be compared with confiding in pocket-aneroid work more than in railroad leveling. Furthermore, the paleontologists have not merely altogether neglected to plot numerous dips as an indication of geological structure, but they have not generally thought it worth while to indicate with any sort of precision the beds that have yielded their fossils; though Fontaine has done something of that kind. Wheatley, alone, gave a measured columnar section of about 180 feet, showing clearly the position of his fossils; but he must have been more a geologist than a paleontologist.

The Pennsylvania foundation of the present conjectures is, however, far from conjectural. We are not here entering upon another system of conjectures based on conjectures, but conjectures based at least on facts; and it is to be hoped that the conjectures themselves may prove to have nothing improbable, violent, unnatural or supernatural in them. The unexpectedly great thickness of the New Red in Montgomery and Bucks counties is not conjectural, but has been ascertained by means of much careful, laborious, time-taking work in the field and in the office. Something like one-half of the field was excellently mapped with ten-foot contour lines by the Philadelphia Water Department several years ago, and the rest was roughly contoured expressly for the New Red investigation, and the completed map of it was in part replaced by some United States geological work just then published. Some two thousand dips were plotted on the map. Some two thousand rock exposures, including all the railroad cuts and many long river-side cliffs, were observed, measured roughly and drawn in columnar section to scale. Besides the written description of each rock-layer, some four thousand rock specimens were taken for a more complete understanding and for comparison one with another. A general columnar section was formed by combining the separate ones, computing the intervals between them, having due regard to the dip,

strike and elevation of each exposure, and proceeding from point to point between the nearest ones, so that no essential error could occur from changes of dip or strike in so small a space, and checking occasionally the computation between two distant points over one route by like computations over another route, with the aid sometimes of a comparison of specimens to identify the beds of one observed section with those of another. The topographical features of the country also aided in working out the structure. A complete publication of all the evidence would have been more costly than perhaps at present desirable, and certainly more so than the funds at hand would permit; but it is hoped that the map and cross-sections just now about to be published will be found to contain enough of the facts to be fully convincing of the substantial accuracy of the results. The map was taken in hand by the lithographer over a year ago, and its publication is now almost daily expected, and may take place before this paper can be printed; so that it is not necessary to give here a map or sections of the Pennsylvania portion of the New Red.

The survey, then, has shown that the so-called New Red in Montgomery county is at least some 27,000 feet thick, and that it may be divided into five parts as follows, from above downwards: shales mostly soft and red, at Pottstown and northeastward, about 10,700 feet thick; shales, in great part hard and green, partly blackish, and dark red, at the Perkasie tunnel and near it, with some small traces of coal, about 2000 feet; shales, mostly soft and red, at Lansdale and near it, about 4700 feet; shales, in great part hard, dark or greenish gray, and blackish, partly dark red, at the Gwynedd and Phœnixville tunnels, with traces of coal, about 3500 feet; shales, mostly soft and red, but in small part dark gray, or green, or blackish, with some beds of brown sandstone and of gray sandstone and pebble rock, at Norristown and eastward, about 6100 feet. That is, in the main, two sets of hard dark shales, with soft red shales above and below each; and the lower set of dark shales thicker, blacker and more carbonaceous than the upper one. Nevertheless, the resemblance of the two sets and the fact that, owing to the great fault, both occur twice near the Delaware have occasioned some confusion. It would probably be fruitless to attempt at present outside of Bucks and Montgomery counties to identify more definite horizons than these five great bodies of rock; and it must still be only with more or less of conjecture that even they can be traced into distant States by the maps and descriptions that have been published.

Even in Pennsylvania, outside of those two counties, the published information is too defective for the purpose. If the State government had ever made possible a topographical survey of the whole field, it might probably be comparatively easy now to trace each subdivision by the help of the topography all the way to the Maryland line. As it is, we can only conjecture roughly the horizons of the fossils that have been found. For example, it is very probable that the vertebrate fossils near Emigs-

ville, York county, came from the Gwynedd shales; for the place would seem to be not far from the horizon of the coal near Liverpool, close by, that most likely corresponds to the other Pennsylvania traces of coal in the Gwynedd shales and to the more abundant Richmond and North Carolina coals. The fossil algæ of A. Wanner, four miles "eastward" from the Goldsboro fossil footprints, in York county, would also seem to be near the Liverpool coal and likewise in the Gwynedd shales, perhaps higher up than the vertebrate fossils. The footprints and algæ described by A. Wanner as about a mile south of Goldsboro, would then seem likely to be in the Lansdale shales, perhaps towards the top of them.

In Virginia, it is doubtful whether the total New Red thickness is anything like so great as in Pennsylvania; but, according to Fontaine's description (*U. S. Geol. Survey*, Monograph, 1883, vi, 6), there would seem to be representatives there of all five divisions, with a confusion of the two sets of dark shales, on account of their occurring quite disconnectedly one in the eastern and the other in the western areas. The accompanying map, copied from Oswald J. Heinrich's map in the *Transactions of the American Institute of Mining Engineers*, Vol. vi, Pl. v, 1879, with the slight change of omitting certain misleading symbols and adding some names of fossil places, will perhaps sufficiently show the geographical position of the New Red in Virginia and North Carolina.

Fontaine says (p. 6): "The strata of all the areas may be divided into three groups, and this division is most marked in the two eastern coal-bearing areas [the Richmond basin, including the barren Hanover county portion at its northern end, and the Cumberland, or Farmville, basin]. The coal in these occurs in the middle group and is accompanied by a large proportion of black shales. The lowest beds of the two coal-bearing areas are sandstones and shales of a predominant gray color, but with some red strata. . . . . The Cumberland area contains much more of them [the red] than the Richmond area. . . . . The more western areas . . . . show also the threefold grouping of the strata, but in a less marked manner. Where plants and traces of coal occur in them they are found in the middle member. This member contains a comparatively small amount of red beds. The beds are here often gray or greenish gray. The lower group of these areas is usually characterized by the large amount of red strata present and the absence of traces of vegetable matter, except silicified wood. The upper group or member varies in character with the locality, but . . . . the beds are usually barren sandstones and shales, formed of well-sorted components."

It seems highly probable that the middle member of these western areas, near the Blue Ridge, in Northern Virginia, is the same as the Perkasie shales and that the middle member, at least, of the Richmond and Farmville coal fields corresponds to some part of the Gwynedd and Phœnixville shales, notable in Pennsylvania, even, as containing some thin coal beds. Indeed, it is possible that the whole of the Mesozoic of those two fields may be included in the Gwynedd shales.

A Conjectural Map of the American New Red of New Jersey and New York,

By Benjamin Smith Lyman.

6 April, 1894.

SCALE:— 10 MILES TO AN INCH, OR 1: 633 600.

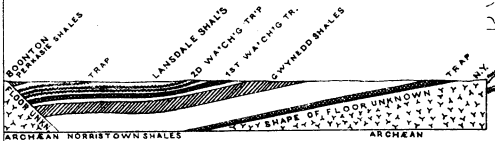
0 5 10 15 20 MILES

TRAP RUBBISH. TRAP IN PLACE.

THE MAP IS BASED ON THE N. JERSEY STATE GEOLOGICAL MAPS AND N. H. DARTON'S, WITH AID FROM THE TOPOGRAPHY. THE GEOLOGICAL STRUCTURE IS ESPECIALLY CONJECTURAL FOR A DOZEN MILES NORTH, WEST AND SOUTH OF SOMERVILLE; BUT ELSEWHERE SEEMS CLEAR, THOUGH THE LIMITS OF THE ROCK GROUPS ARE NOT PRECISELY KNOWN.

Cross-Section

From Boonton to New York City.



Columnar S

Fossil Horizons:

N. Vernon
Milford, Boonton

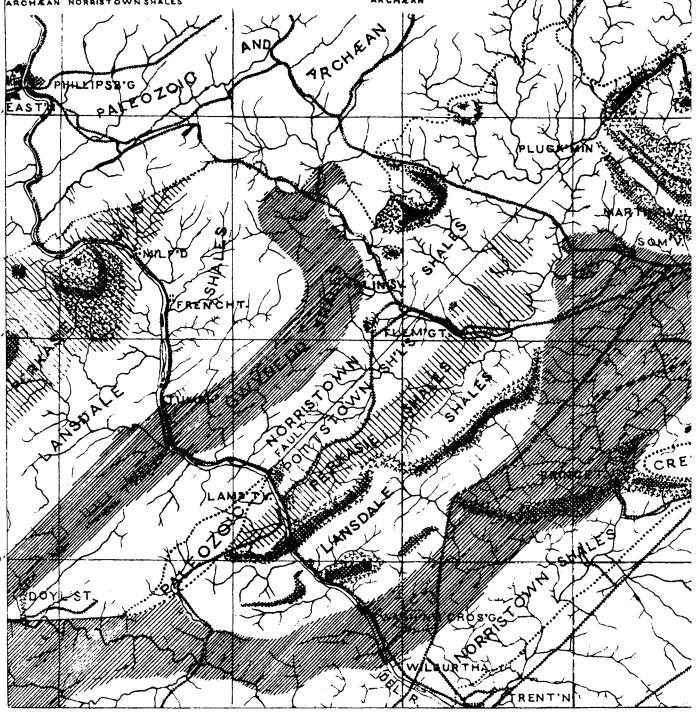
Pompton
Whitehall, N. Prov.

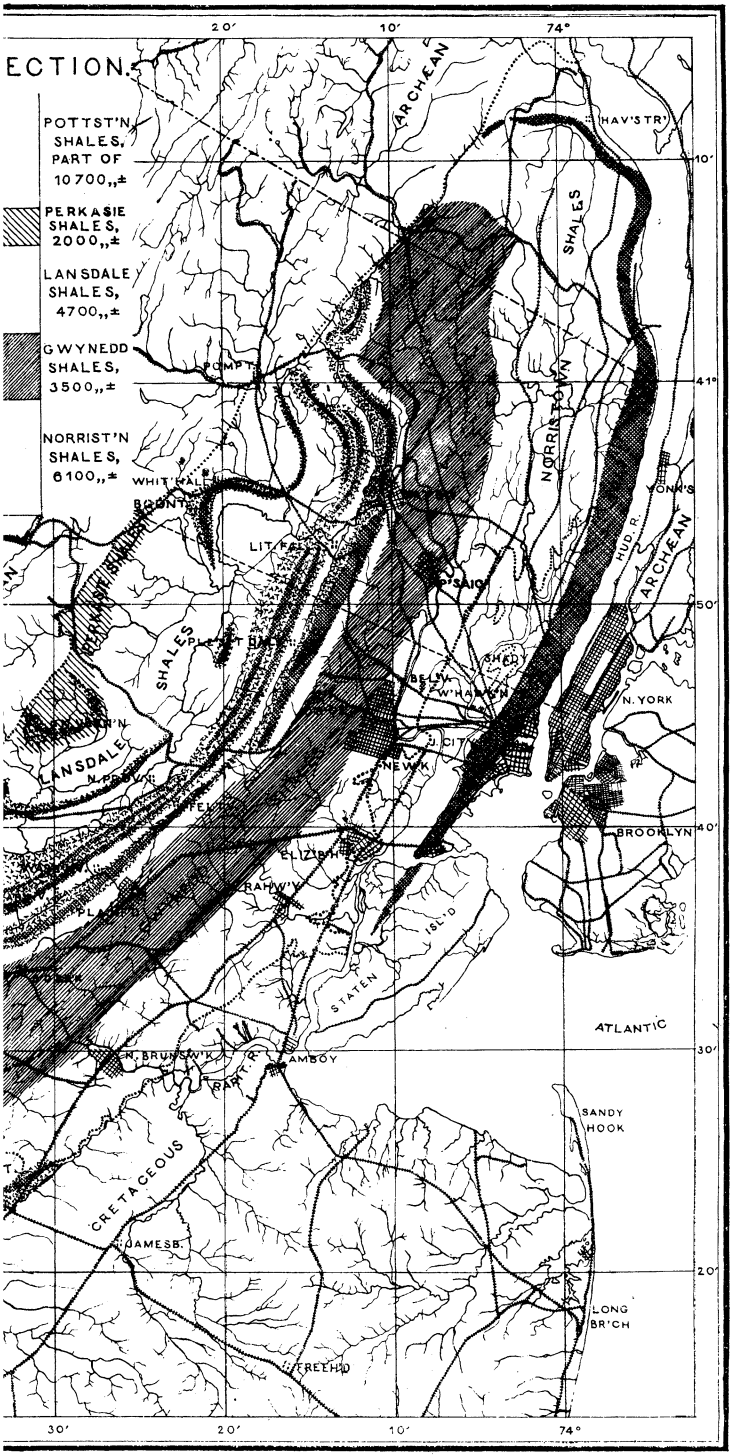
Pluc'min, Martinsv.
War'nv., Wash'nv., Felt'v.

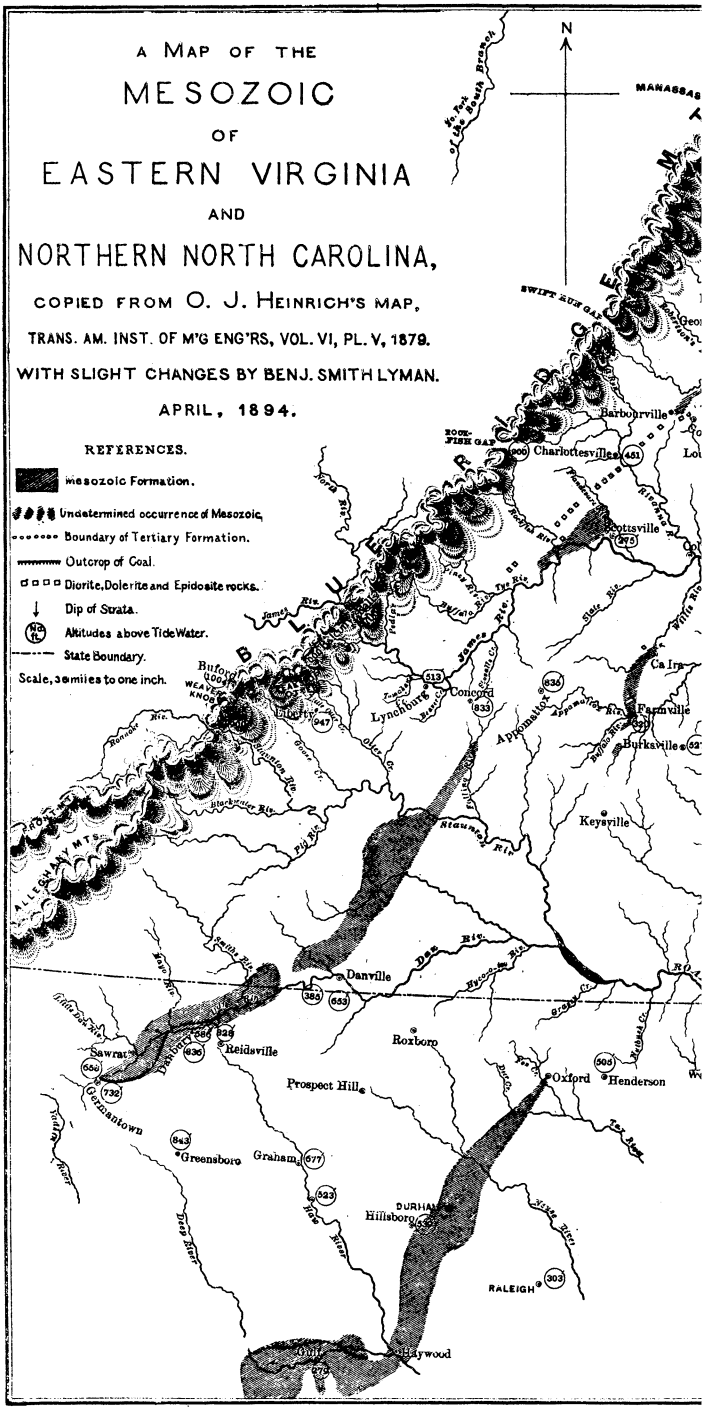
Tumble
Wash'n's Cros's'g

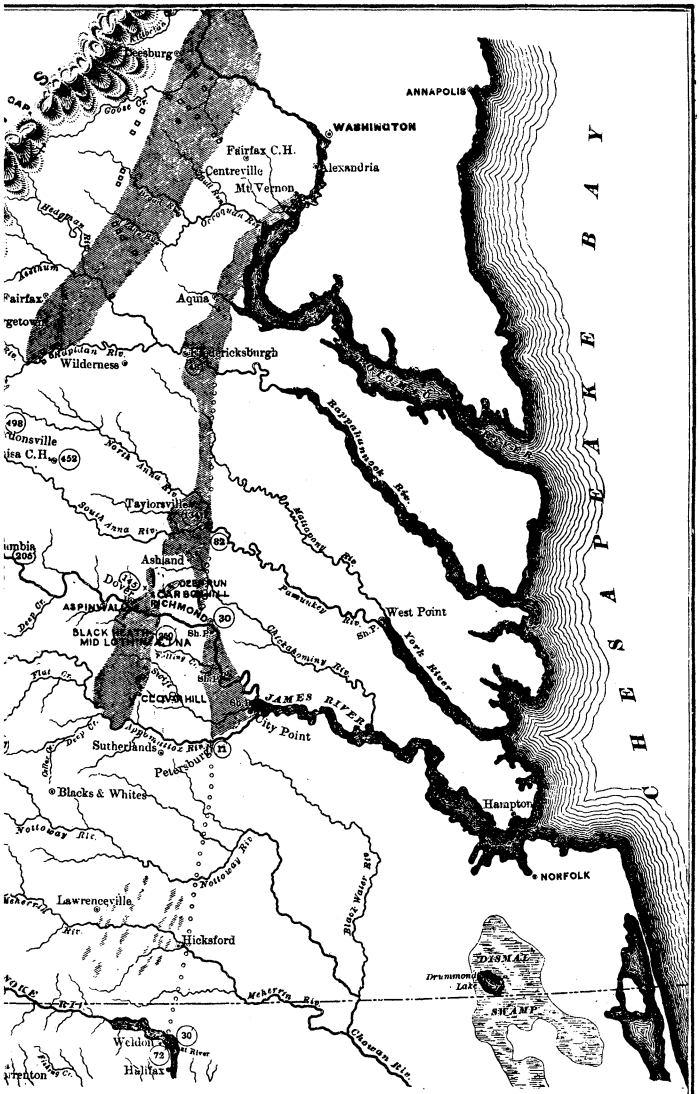
Klinesville

Newark, Belleville
Wilburtha




ECTION.
POTTST'N SHALES, PART OF 10700,,±
PERKASIE SHALES, 2000,,±
LANSDALE SHALES, 4700,,±
GWYNEDD SHALES, 3500,,±
NORRIST'N SHALES, 6100,,±
20'
10'
74°
ARCHEAN
HAV'S TR'
SHALES
NORRISTOWN
POMPT.
WHIT HALL
LIT P.
PASAIC
HUD. R.
ARCHEAN
SHALES
PLAINFIELD
BELLV.
W'HAVEN
N. YORK
LANSDALE
N. BRUNSW'K
NEWW'K
ELIZBTH
RAHW'Y
BROOKLYN
ISL'D
STATEN
ATLANTIC
N. BRUNSW'K
RARIT. R.
AMBOY
SANDY HOOK
CRETACEOUS
JAMESB.
LONG BR'CH
FREEHD
41°
40'
30'
20'


A MAP OF THE
MESOZOIC
OF
EASTERN VIRGINIA
AND
NORTHERN NORTH CAROLINA,
COPIED FROM O. J. HEINRICH'S MAP,
TRANS. AM. INST. OF M'G ENG'RS, VOL. VI, PL. V, 1879.
WITH SLIGHT CHANGES BY BENJ. SMITH LYMAN.
APRIL, 1894.
REFERENCES.
Mesozoic Formation.
Undetermined occurrence of Mesozoic.
Boundary of Tertiary Formation.
Outcrop of Coal.
Diorite, Dolerite and Epidosite rocks.
Dip of Strata.
Altitudes above Tide Water.
State Boundary.
Scale, 30 miles to one inch.
N
MANASSAS
BLUE RIDGE
ALLEGHANY MTS.
SWIFT RUN GAP
ROCK-FISH GAP
Barbourville
Charlottesville
Scottsville
Lynchburg
Concord
Appomattox
Farmville
Burkesville
Keysville
Buford
WEAVER KNOB
Liberty
Danville
Sawrat
Danbury
Reidsville
Germantown
Roxboro
Prospect Hill
Oxford
Henderson
Greensboro
Graham
DURHAM
Hillsboro
RALEIGH
Haywood
James Riv.
Roanoke Riv.
Staunton Riv.
Dan Riv.
Smiths Riv.
Mayo Riv.
Pig Riv.
Blackwater Riv.
Yadkin River
Deep River
Haw River
Neuse River
Tar River
Appomattox Riv.
Rivanna R.
Slate Riv.
Willis Riv.
Buffalo Riv.
Tye Riv.
Otter Cr.
Goose Cr.
Falling Riv.
Hyco-o-tee Riv.
Grassy Cr.
Nutbush Cr.
Little Dan Riv.
North Riv.
No. Fork of the South Branch
906
451
275
513
833
836
947
385
653
586
828
836
656
732
843
677
523
505
303



NOTE BY B. S. L.— FROM THIS MAP AND PROF. FONTAINE'S ACCOUNT, THE RICHMOND AND THE DEEP RIVER COALS WOULD SEEM TO BE OF THE SAME HORIZON, AND THE FARMVILLE AND DAN RIVER COALS ALSO OF THE SAME; AND ALL TO BELONG TO THE GWYNEDD SHALES. THE NORTH-WESTERN AREAS, NEXT THE BLUE RIDGE, SEEM TO BE LATER, AND TO CONTAIN THE PERKASIE SHALES. THE NORRISTOWN SHALES MAY OCCUR IN THE EASTERNMOST AREAS.

The Virginia fossils mentioned by Fontaine, forty-two species of plants, all appear to have occurred within the extreme limits of the coal-bearing beds of the middle member of the Richmond and Farmville basins; that is, within a thickness of about 150 feet, and, beyond a doubt, within what corresponds to the Gwynedd shales.

In North Carolina, the composition of the Mesozoic would seem to be very like what it is in Virginia, with three members in the eastern Deep River coal field and three in the western Dan River coal field, each field with its middle member comparatively blackish or greenish and slatelike, with conglomerates and sandstones below, gray, brown and red, and with similar soft and hard red, brown and mottled sandstones above. The description applies more particularly in the Deep River field, but the rocks of the Dan River field are said to be similar and to consist of the same members (see Emmons as reported in *Macfarlane's Coal Regions of America*, pp. 518–520, 526). Moreover, the geographic position of the two fields would seem to make it highly probable that the Deep River rocks would correspond to those of the Richmond coal basin, and Fontaine considers them to do so. The Dan River beds, however, would seem to correspond with those of the Farmville basin, that is, to be the same beds as the Richmond and Deep River beds, but on the western side of an anticlinal. Both the Deep River coals and the Dan River coals would then belong among the Gwynedd shales. It is true, Emmons later considered the lower part of the Deep River darker member to be unconformable and much older, even Permian, and called it the Chatham series; but Fontaine finds nothing in the fossils to confirm such a suspicion.

The North Carolina fossils mentioned by Emmons all come from the Deep River coal field. Only four of them come from what he calls the bituminous slate group of the Chatham series, beds most closely connected with the coals and corresponding, in Fontaine's opinion, to the beds associated with the Richmond coals, the same probably as the middle member of the Richmond coal basin and a part of the Gwynedd shales. The thirty-six other fossil plants all come from higher up, but from what seems to correspond to the middle or upper part of the Gwynedd shales within, say, at most 2000 feet above the coal beds, and below the thick, "red marly sandstones," that may correspond to the upper part of the Gwynedd shales or to the lower part of the Lansdale shales. The North Carolina fossils then all appear in any case to belong to the Gwynedd shales.

As regards the New Red in New Jersey, it was suggested in the previous communication already referred to that possibly a careful study of the topography as set forth in the valuable maps of the New Jersey State Geological Survey might enable the New Red main subdivisions to be traced quite across the State. Later, on actual trial, it did seem possible to accomplish so much rather satisfactorily, and the accompanying map of the New Jersey and New York New Red gives the result. The geo-

logical structure is nearly everywhere quite clear; only within a semicircle for a dozen miles north, west and south of Somerville the indications are not quite certain, and more thorough field work is especially desirable there. Elsewhere, too, the limits of the different subdivisions cannot be supposed to be very precisely marked. In the main, however, the geological structure given in the map seems unquestionable and unmistakably confirmed by the published dips, by the topography, by the trap sheets and by the perfect correspondence and harmony throughout of one part with another.

It is readily seen from the map and its sections that the fossil horizons of Weehawken and Shadyside belong to the lower part of the Norristown shales, and the horizon of Newark and Belleville to the upper part of the same, as indicated also by the close lithological resemblance of the brown building stone of these places to the stone found in Pennsylvania only at that horizon, particularly at the Yardleyville, Newtown and other quarries. The Wilburtha fossils opposite Yardleyville on the Delaware obviously belong to nearly the same horizon.

The Klinesville fossils come clearly from the Gwynedd shales, apparently a little below their middle, and the fossils found near Washington's Crossing and Tumble Station must be from near the top of the same shales. The fossils of Little Falls, Pleasantdale, Feltville, Washingtonville, the Field Copper Mine near Warrenville ("near Plainfield," of Newberry), are all evidently close to one horizon, and that probably in the Lansdale shales near their bottom. The fossils of Martinsville and Pluckamin are perhaps slightly higher up in the same division; those of Whitehall and New Providence apparently at about one horizon slightly above the middle of that division, and those of Pompton Furnace still higher towards the top of the division. The fossils of Boonton would seem to be of about the same horizon as those of Milford in the Perkasie shales, near the bottom; and those of New Vernon slightly higher in the same shales.

It may be noticed that the map represents the trap in place as generally much less extensive than it is commonly given in New Jersey geological maps. It appears to have been customary, both here and in the Connecticut Valley, to infer the existence of solid trap everywhere beneath the surface exposures of trap bowlders and decomposed trap earth. From observations in Pennsylvania, however, it seems far more probable that the solid trap in place is of much narrower dimensions, as often appears where streams have cut their way through hills. It seems quite natural, too, that so hard a rock as the trap generally is should be left by the erosion in the form of hills, standing out prominently above the neighboring spaces that are underlain by the comparatively unresisting sedimentary rocks, chiefly soft shales. It is also quite natural that abundant remains of broken blocks or bowlders and decomposing earth from the trap, so durable is it, should long exist not only beneath the places where its solid bed once lay, but also be carried by the eroding waters to some little

distance in other directions from the outcrops of the solid undisturbed trap. The surprising thing, indeed, is perhaps that the trap hills are not more prominent in the midst of such soft rocks, and that the trap bowlders and gradually decomposing rubbish should not have accumulated to a still greater extent. The explanation, no doubt, is that the trap, with all its hardness and, in human experience, durability, is yet in geological ages comparatively easy of decomposition. At some places it is obviously decomposed almost to incoherence in large masses yet in place, only made visible by railroad cuts. It has therefore seemed advisable to mark the trap as solid, in place, only where it appears to have occasioned hills of some prominence ; and, even so, the true extent may have been exaggerated, particularly, perhaps, in the case of the Palisade trap along the Hudson river, where there may well be concealed important beds of shales between separate sheets of trap.

It will be seen from the map that not all of the trap is in overflow sheets ; but that, although none of it appears to be in intrusive sheets, there are some dikes cutting across the sedimentary bedding. Surely that is not to be wondered at; and it is not surprising that such cases of dikes should occur more numerously among the older sedimentary beds. For those parts of the field are the ones where the upper beds have been wholly carried away by erosion, and with them whatever overflow sheets may have been supplied by the still remaining dikes.

The map shows that in New Jersey, the same as in Eastern Pennsylvania, the structure of the New Red is much less simple near its northwest border than towards its southeast ; and that the old idea of nothing but northwesterly dips is far from correct.

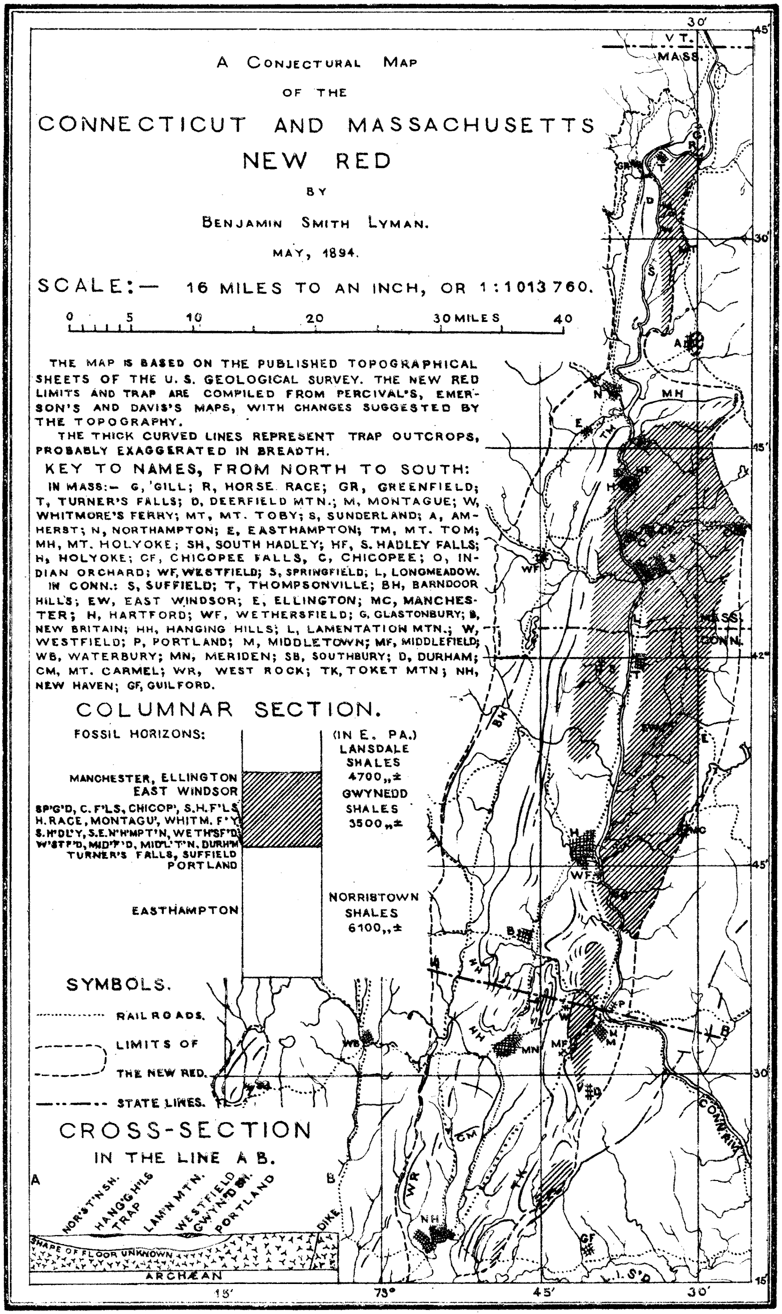
It is noticeable that the thickness of the New Red is much less towards the northeastern end of the field than it is near the Delaware and especially less than in Montgomery county, Pa. ; and that the diminution is occasioned by the absence of the upper beds, while the lower ones do not seem to vary very greatly in amount.

The diminution extends into Connecticut in greater degree, and still more so in Massachusetts, as is to be seen in the accompanying map of the New Red there. It is possible that the idea of the very limited paleontological range and thickness of the whole American New Red may have largely originated in the small extent of the Massachusetts and Connecticut series, the earliest to be studied. Another error may perhaps be traced in great part to the same source. The New Red, namely, is persistently called New Red sandstone ; though in Eastern Pennsylvania a very small part of the beds, perhaps hardly one-twentieth, are sandstone, and the rest are all shales, or at most sandy shales. In Massachusetts, however, a much larger share of the diminished series would appear to be sandstone ; and that fact, together with the time-honored name of the English New Red sandstone was doubtless the cause of giving what is lithologically so inappropriate a name to our American rocks.

The accompanying little map of the Connecticut and Massachusetts

New Red is compiled from the United States Geological Survey topographical sheets so far as published (some parts of the Connecticut field being deficient), and from Percival's geological map of Connecticut, of 1842, and Prof. Emerson's map of the Massachusetts New Red, and Prof. Davis' partial mapping of the Connecticut New Red; but a number of changes have been made according to the indications of the topography. These geological maps gave, for our present purposes, chiefly the outside limits of the New Red and the occurrences of trap. The topography seemed to indicate clearly the necessity of reducing the extent of the trap, in some places very much; and, even as now drawn, the breadth of the trap may be, strictly speaking, somewhat exaggerated, though probably harmlessly so and not inconveniently for better conspicuousness. Notwithstanding the short-sighted niggardliness of the Connecticut government of the time, that did not enable Percival to give in his report more, he says, than "a hasty outline, written mainly from recollection," of his ample field observations, his map has been the great authority for the Connecticut New Red; but it is painful to find that the base itself of the map is extremely inaccurate, not unlike other maps of that date, and even later, in States further west and south. It is probable, also, that he considered every bowlder of trap to indicate that solid trap in place lay immediately below; and consequently many of his trap masses have no corresponding topographical indications. Prof. Davis has already made some just criticism of the map, and, for example, has said: "that the little ridges north of Toket mountain, marked with much detail of curvature on Percival's map, are disappointing when examined on the ground" (*U. S. Geol. Survey*, 7th Ann. Rept., p. 481). It seems highly improbable but that many of the numerous marks for trap on Percival's map cannot represent trap in place. In Eastern Pennsylvania, quite outside the region of glacial drift, exposures of trap in place are very rare, and it is not easy to suppose that they can be anything like so common as his map would seem to indicate in a region heavily covered with drift. It has consequently seemed proper enough to omit many of his smaller trap masses from the present map, wherever there was no topographical feature to corroborate their existence. The lack of the New Haven topographical sheet, not yet published, has perhaps led to the omission of some of the little trap masses that might have been inserted, but they would not be important for the present purpose.

As Prof. Davis has justly remarked, many of Percival's curves in the trap are simply the result of variations in the shape of the surface of the ground, where the outcrop of a bed or sheet, dipping gently, retreats as it sinks into a valley, or advances as it climbs a hill, and such curves may be properly retained. But some of Percival's curves do not seem to have any real support in the topography; and at other places, for example, north of Middletown, the topography gives quite a changed interpretation for the structure. In Massachusetts, too, near Mt. Toby and at the eastern end of Mt. Holyoke the topography seems to require the changes that have been made in the mapping of the trap.


A CONJECTURAL MAP
OF THE
CONNECTICUT AND MASSACHUSETTS
NEW RED
BY
BENJAMIN SMITH LYMAN.
MAY, 1894.
SCALE:— 16 MILES TO AN INCH, OR 1:1013760.
0 5 10 20 30 MILES 40
THE MAP IS BASED ON THE PUBLISHED TOPOGRAPHICAL SHEETS OF THE U. S. GEOLOGICAL SURVEY. THE NEW RED LIMITS AND TRAP ARE COMPILED FROM PERCIVAL'S, EMERSON'S AND DAVIS'S MAPS, WITH CHANGES SUGGESTED BY THE TOPOGRAPHY.
THE THICK CURVED LINES REPRESENT TRAP OUTCROPS, PROBABLY EXAGGERATED IN BREADTH.
KEY TO NAMES, FROM NORTH TO SOUTH:
IN MASS:— G, 'GILL; R, HORSE RACE; GR, GREENFIELD; T, TURNER'S FALLS; D, DEERFIELD MTN.; M, MONTAGUE; W, WHITMORE'S FERRY; MT, MT. TOBY; S, SUNDERLAND; A, AMHERST; N, NORTHAMPTON; E, EASTHAMPTON; TM, MT. TOM; MH, MT. HOLYOKE; SH, SOUTH HADLEY; HF, S. HADLEY FALLS; H, HOLYOKE; CF, CHICOPEE FALLS, C, CHICOPEE; O, INDIAN ORCHARD; WF, WESTFIELD; S, SPRINGFIELD; L, LONGMEADOW.
IN CONN.: S, SUFFIELD; T, THOMPSONVILLE; BH, BARNDOOR HILLS; EW, EAST WINDSOR; E, ELLINGTON; MC, MANCHESTER; H, HARTFORD; WF, WETHERSFIELD; G, GLASTONBURY; B, NEW BRITAIN; HH, HANGING HILLS; L, LAMENTATION MTN.; W, WESTFIELD; P, PORTLAND; M, MIDDLETOWN; MF, MIDDLEFIELD; WB, WATERBURY; MN, MERIDEN; SB, SOUTHBURY; D, DURHAM; CM, MT. CARMEL; WR, WEST ROCK; TK, TOKET MTN; NH, NEW HAVEN; GF, GUILFORD.
COLUMNAR SECTION.
FOSSIL HORIZONS:
MANCHESTER, ELLINGTON
EAST WINDSOR
SP'G'D, C. F'LS, CHICOP', S.H.F'LS
H. RACE, MONTAGU', WHITM. F'Y
S.H'DL'Y, S.E.N'H'MPT'N, WETH'SF'D
W'STF'D, MID'F'D, MID'L'T'N, DURH'M
TURNER'S FALLS, SUFFIELD
PORTLAND
EASTHAMPTON
(IN E. PA.)
LANSDALE
SHALES
4700,,±
GWYNEDD
SHALES
3500,,±
NORRISTOWN
SHALES
6100,,±
SYMBOLS.
RAILROADS.
LIMITS OF
THE NEW RED.
STATE LINES.
CROSS-SECTION
IN THE LINE A B.
A
B
NOR'ST'N SH.
HANG'G H'LS TRAP
LAM'N MTN.
WESTFIELD
GWYN'D SH.
PORTLAND
DIKE
SHAPE OF FLOOR UNKNOWN
ARCHÆAN
VT.
MASS.
CONN.
CONN. RIV.
L. I. S'D
30′
45′
42°
15′
73°

The map shows, in spite of some uncertainty about the true limits of the different subdivisions of the shales, that the quantity of the New Red that occurs in Connecticut and Massachusetts is probably decidedly less than in Central New Jersey, and that the diminution is still most likely due, not to a proportional thinning of the several subdivisions, but to the total absence of the upper beds, leaving the lower divisions apparently not very different in thickness from what they are in Eastern Pennsylvania. Their thickness, however, needs to be determined with more precision by a closer consideration of the hitherto only scantily published dips. Owing to this evident diminution of the total thickness, it is not necessary to retain, with reversed throws, the series of parallel longitudinal faults that has been proposed for Connecticut.

The geological structure indicated by the map seems very natural and quite in harmony with all the recorded facts and to make no serious fault necessary. The dips near Middletown and Portland and westward would seem to be very gentle, and "occasionally westerly" (J. D. Dana, *Am. Jour. Sci.*, 1891, Vol. xlii, p. 446), so as to justify the indication given of a very shallow basin there, bringing quite naturally the brownstone of the Norristown shales to the surface at Portland. There seems to be another narrower shallow basin or two just west of that one. A very low anticlinal (not a great fault) north of Meriden apparently enables the same brownstone to crop out so far north as Longmeadow, in the southern edge of Massachusetts. The geological structure towards the eastern edge of the New Red, to the dip, seems to be much more complicated than towards the western edge; just as in New Jersey and Pennsylvania it is so along the western edge, to the dip there.

The fossil horizons can be estimated roughly, but probably without very great error. The Easthampton (Mass.) fossil would seem to have come from somewhere near the middle of the Norristown shales; the Portland fossils from the same shales, somewhat nearer their top, and the fossils from the west bank of the Connecticut at the Enfield bridge in Suffield, and those of Turner's Falls again from the same shales, perhaps still closer to the top. The fossils of the small detached area at Southbury also belong probably to those shales, but possibly a little higher. The fossils of Durham, Middlefield, west of Middletown, Westfield (Conn.), Wethersfield, Mittineaque Falls in West Springfield, southeastern Northampton (close above Holyoke), northern South Hadley, Whitmore's Ferry (in Sunderland), Montague and the Horse Race (on Connecticut river in Gill), all seem to belong very closely to one horizon, and that just above the bottom of the Gwynedd shales. The fossils of Chicopee and those between Chicopee and Springfield (possibly those of Springfield, too, if not a little lower) and those of South Hadley Falls would seem to be from the same shales slightly higher up; and the fossils from Chicopee Falls again from the same shales, possibly still slightly higher up; and those from Amherst perhaps yet higher. The fossil bones from East Windsor would appear also to come from the Gwynedd shales, but near their top; and those

from Ellington and Manchester probably from just below their top. Almost all the New Red fossils in these two States, then, seem to have come from the Gwynedd shales, as we have seen is the case in the other States.

It may be worth while to give here lists of all the recorded New Red fossils, arranged according to the different horizons for the sake of easy comparison, beginning at the bottom and proceeding upwards.

Norristown Shales.

Very near the bottom, at Weehawken, N. J. :

Ischypterus Braunii, Newb. (Newb., U. S. Geol. Surv., Mon. xiv, p. 43).
Estheria ovata, Lea (N. J. Geol. Surv. Rep., 1888, pp. 26, 28, 29).
Plants (L. P. Gratacap, Am. Naturalist, xx, p. 245).
Footmarks (do., p. 246).

Likewise very near the bottom, at Shady Side, N. J. :

Estheria ovata, Lea (N. J. G. S. Rep., 1888, pp. 26, 29).
Imperfect remains of fishes (do., pp. 26, 29).

About 3500 feet below the top, below Norristown and at Ft. Washington, Pa. :

Undetermined plants, found a few days ago by Prof. Heilprin's geological class.

About 3000 feet below the top, at Greenville, four miles and a half easterly from Doylestown, Pa. :

Calamitoid plant (Schizoneura planicostata, Font.?), "near Doylestown" (N. Y. Ac. Sci. Trans., 1885, p. 17).
Calamites (?) undetermined (A. P. S. Proc., Vol. xxxiii, p. 7, Feb., 1894).

Towards the top, at the Rocky Hill quarries, a little west of Hartford, Conn.:

Footmarks (Hitchc., Mass. Geol. Rep., 1841, p. 466).

Towards the top, at Easthampton, Mass.:

Clathropteris platyphylla, Brong. (Newb., Mon. xiv, p. 94).
Brontozoum giganteum, E. H. (Suppl. to Ichn., p. 24).
Mollusk allied to Rudistæ Lamk. (?) (Hitchc., Ich., p. 6).

Towards the top, at Wilburtha, N. J.:

Estheria (N. J. G. S. Rep., 1888, p. 29).
Plant remains, imperfect (do., p. 29).

Towards the top, one mile above Prallsville, N. J.:

Estheria (N. J. Geol. Rep., 1888, p. 30).

Near the top, at Newark, N. J.:

Lepidodendron Weltheimianum, Presl. (N. J. G. S. Rep., 1879, p. 26).
Equisetum Meriani (?) (Newb., Mon. xiv, p. 86).
Dioönites longifolius, Emmons (do., p. 92).
Clathropteris platyphylla, Brong. (do., p. 94).
Palissya Braunii, Endl. (doubtful) (do., pp. 13, 94).

Near the top, at Belleville, N. J.:

Lepidodendron Weltheimianum, Presl. (N. J. G. S. Rep., 1879, p. 26).
Bone fragment, well preserved (Cook, N. J. Geol. Rep., 1885, p. 95).

Near the top, at Portland, Conn.:

Dendrophycus triassicus, Newb. (same as Desorii Lesqx., Newb., Mon. xiv, p. 82).
Cunichnoides marsupialoideus, E. H. (Ich., p. 55).
Brontozoum exsertum, E. H. (do., p. 67).
" validum, E. H. (do., p. 68).
" Sillimanium, E. H. (do., p. 69).
Grallator gracillimus, E. H. (?) (do., p. 74).
Isocampe Moodii, E. H. (do., p. 120).
Otozoum Moodii, E. H. (do., p. 125).
Hoplichnus equus, E. H. (do., p. 135).
Impressions of bones apparently ornithic (W. B. Rogers, Bost. Nat. Hist. Soc. Proc., Vol. vii, p. 396).

Near the top, between Wethersfield and Hartford, Conn.:

Plectropterna (Sauroidichnites) minitans, E. H. (1841, p. 482).

Near the top, at Suffield, Conn.:

Alga (Hitchcock, Mass. Geol. Rep., 1841, p. 453).
Plant, possibly a Voltzia (do., p. 451).
Brontozoum (Ornithoidichnites) giganteum, E. H. (do., pp. 466, 485).

Near the top, on Mt. Holyoke, Mass.:

Brontozoum validum, E. H. (Ich., p. 68).

Near the top, at Montague City, one mile south of Turner's Falls, Mass.:

Tridentipes ingens, E. H. (Ich., p. 89).

Near the top, at Turner's Falls, Mass.:

Pachyphyllum simile, Newb. (Newb., Mon. xiv, p. 88).
Pachyphyllum brevifolium (do., p. 89).
" peregrinum, Schimper (Font., U. S. G. Surv., Mon. vi, p. 108).
Actinopteris quadrifoliata, Font. (Font., Mon. vi, p. 121).
Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).
Ischypterus tenuiceps, Ag. (do., p. 33).
" parvus, W. C. R. (do., Pl. xiii).
Anomoepus intermedius, E. H. (Sup., p. 2).
" curvatus, E. H. (do., p. 5).
" minimus, E. H. (do., p. 5).
" gracillimus, E. H. (do., p. 6).
Anisopus gracilior, E. H. (do., p. 6).
Brontozoum divaricatum, E. H. (do., p. 7).
Grallator parallelus, E. H. (do., p. 7).
" gracilis, C. H. H. (do., p. 8).
Leptonyx lateralis, E. H. (do., p. 8).
Comptichnus obesus, E. H. (do., p. 9).
Trihamus elegans, E. H. (do., p. 9).
Anticheiropus hamatus, E. H. (do., p. 11).
Harpedactylus crassus, E. H. (do., p. 12).
" gracilior, E. H. (do., p. 12).
Lunula obscura, E. H. (do., p. 17).
Bisulcus undulatus, E. H. (do., pp. 66, 84).
Trisulcus laqueatus, E. H. (do., p. 19).
Grammichnus alpha, E. H. (do., p. 19).
Ampelichnus sulcatus, E. H. (do., p. 19) ("Possibly a plant").
Climacodichnus corrugatus, E. H. (do., p. 20).
Ænigmichnus multiformis, E. H. (do., p. 20).
Brontozoum giganteum, E. H. (Sup., p. 24).
" approximatum, E. H. (Sup., p. 24).
Brontozoum minusculum, E. H. (do., p. 24).
" exsertum, E. H. (do., p. 67).
" Sillimanium, E. H. (do., p. 69).
Brontozoum isodactylum, E. H. (do., p. 70).
Plesiornis mirabilis, E. H. (do., p. 83).
Anamœpus minor, E. H. (Ich., p. 58).
Anisopus Deweyanus, E. H. (Sup., p. 64).
Anisopus gracilis, E. H. (Ich., p. 62).
Amblonyx giganteus, E. H. (do., p. 71).
" Lyellianus, E. H. (do., p. 72).
Grallator cursorius, E. H. (do., p. 73).
" tenuis, E. H. (do., p. 73).
" gracillimus, E. H. (do., p. 74).
" cuneatus, E. H. (do., p. 75).
Platypterna recta, E. H. (do., p. 85).
" varica, E. H. (do., p. 86).
" gracillima, E. H. (do., p. 86).
Tridentipes elegantior, E. H. (do., p. 90).
Corvipes lacertoideus, E. H. (do., p. 98).
Plesiornis quadrupes, E. H. (do., p. 103).
Typopus abnormis, E. H. (do., p. 106).
Plectropterna minitans, E. H. (do., p. 109).
Plectropterna angusta, E. H. (Sup., p. 67).
" lineans, E. H. (do., p. 67).
Harpedactylus gracilis, E. H. (Ich., p. 113).
Xiphopeza triplex, E. H. (do., p. 113).

Antipus bifidus, E. H. (do., p. 116).
Chimæra Barratti, E. H. (do., p. 119).
Isocampe strata, E. H. (do., p. 120).
Otozoum Moodii, E. H. (do., p. 125).
Macropterna vulgaris, E. H. (do., p. 129).
" divaricans, E. H. (do., p. 129).
Shepardia palmipes, E. H. (do., p. 131).
Lagunculipes latus, E. H. (do , p. 132).
Selenichnus falcatus, E. H. (do., p. 133).
" breviusculus, E. H. (do., p. 134).
Hoplichnus poledrus, E. H. (do., p. 136).
Helcura caudata, E. H. (do., p. 141).
Helcura anguinea, E. H. (do., p. 141).
Exocampe arcta, E. H. (do., p. 142).
" ornata, E. H. (do., p. 143).
Harpagopus dubius, E. H. (do., p. 148).
Bifurculipes scolopendroideus, E. H. (do., p. 154).
Hexapodichnus horrens, E. H. (do., p. 158).
Copeza triremis, E. H. (do., p. 159).
Unisulcus Marshi, E. H. (do., p. 160).
" intermedius, E. H. (do., p. 161).
Unisulcus minutus, E. H. (do., p. 161).
Cunicularius retrahens, E. H. (do., p. 163).
" magnus, E. H. (do., p. 164).

Near the top, at the Lily Pond Quarry, on R. Field's farm, in Gill, near Turner's Falls, Mass.:

Acanthichnus alternans, E. H. (Sup., p. 14).
" anguineus, E. H. (do., p. 14).
" trilinearis, E. H. (do., p. 15).
Copeza propinquata, E. H. (do., p. 16).
" punctata, E. H. (do., p. 16).
Conopsoides curtus, E. H. (do., p. 16).
Harpepus capillaris, E H. (do., p. 16).
Sagittarius alternans, E. H. (do., p. 16).
Bisulcus undulatus, E. H. (do., pp. 55, 66, 76.
Brontozoum giganteum, E. H. (do., p. 24).
" approximatum, E. H. (do., p. 24).
Brontozoum minusculum, E. H. (Ich., p. 66).
Brontozoum tuberatum, E. H. (do., p. 66).
Plesiornis mirabilis, E. H.. (do., p. 83).
Anisopus Deweyanus, E. H. (Sup., p. 44).
" gracilis, E. H. (Ich., p. 62).
Grallator formosus, E. H. (do., p. 76).
Argozoum disparidigitatum, E. H. (do., p. 82).
Argozoum paridigitatum, E. H. (do., p. 82).
Tridentipes elegantior, E. H. (do., p. 90).
" uncus, E. H. (do., p. 92).
Gigantitherium caudatum, E. H. (do., p. 95).
Gigantitherium minus, E. H. (do., p. 95).
Hyphepus Fieldi, E. H. (do., p. 97).
Corvipes lacertoideus, E. H. (do., p. 98).
Tarsodactylus caudatus, E. H. (do., p. 99).
Apatichnus circumagens, E. H. (do., p. 100).
Plesiornis quadrupes, E. H. (do., p. 103).
Plesiornis pilulatus, E. H. (do., p. 104).
Orthodactylus floriferus, E. H. (do., p. 114).
" introvergens, E. H. (do., p. 114).
Orthodactylus flexiloquis, E. H. (do., p. 115).
Arachnichnus dehiscens, E. H. (do., p. 117).
Macropterna divaricans, E. H. (do., p. 129).
" gracilipes, E. H. (do., p. 130).
Cheirotheroides pilulatus, E. H. (do., p. 131).
Saltator caudatus, E. H. (do., p. 138).
Chelonoides incedens, E. H. (do., p. 140).
Helcura surgens, E. H. (do., p. 141).
" anguinea, E. H. (do., p. 141).
Exocampe arcta, E. H. (do., p. 142).
Ptilichnus anomalus, E. H. (do., p. 145).
" typographus, E. H. (do., p. 140).
" pectinatus, E. H. (Sup., p. 55).
" hydrodromus, E. H. (Ich., p. 146).
Acanthichnus cursorius, E. H. (do., p. 151).
" saltatorius, E. H. (do., p. 151).
Acanthichnus tardigradus, E. H. (do., p. 151).
Bifurculipes elachistotatus, E H. (do., p. 154).
Hexapodichnus magnus, E. H. (do., p. 158).
Cochlea archimedea, E. H. (do., p. 162).
Halysichnus laqueatus (do., p. 162).
" tardigradus (do., p. 163).

Near the top, on Field's farm, in Gill, near Turner's Falls, Mass.:

Plant, ten feet long (Hitchc., Ichn., p. 170).
Platypterna digitigrada, E. H. (Ich., p. 86).
Apatichnus bellus, E. H. (do., p. 101).
Plectropterna gracilis, E. H. (do., p. 109).
Orthodactylus linearis, E. H. (do., p. 115).
Stenodactylus curvatus, E. H. (do., p. 117).
Saltator bipedatus, E. H. (?) (do., p. 137).
Hamipes didactylus, E. H. (do., p. 150).
Conopsoides larvalis, E. H. (do., p. 152).
Bifurculipes laqueatus, E. H. (do., p. 153).
Bifurculipes tuberculatus, E. H. (do., p. 153).

Grammepus erismatus, E. H. (do., p. 156).
" unordinatus, E. H. (do., p. 156).
Lithographus hieroglyphicus, E. H. (do., p. 156).
Lithographus cruscularis, E. H. (do., p. 157).
Cochlichnus anguineus, E. H. (do., p. 161).
Sphaerapus larvalis, E. H. (do., p. 161).

Near the top, in Field's orchard, in Gill, near Turner's Falls, Mass.:

Anisopus gracilis, E. H. (Ich., p. 62).
Stratipes latus, E. H. (do., p. 149).

Near the top, at the quarry near Roswell Field's house, in Gill, Mass.:

Anamoepus major, E. H. (Ich., p. 57).

Probably in the Norristown shales, at Southbury, Conn.:

Tree trunk (Hitchcock, Rep., 1841, p. 456).
Catopterus gracilis, J. H. R. (Newberry, Mon. xiv, p. 55).

Gwynedd Shales.

Towards the bottom at Egypt, N. C.:

Acrostichides Egyptiacus, Emmons (Font., Mon. vi, p. 99).

Towards the bottom, in the Deep River coal field, N. C.:

Acrostichides princeps, Schenk (?) (Font., Mon. vi, p. 99).
Pariostegus myops, Cope (Cope, N. C. Geol. Rep., 1875, App., p. 32).
Dictyocephalus elegans, Leidy (do., p. 32).
Belodon caroliniensis, Emm. (do., p. 34).
" priscus, Leidy (do., p. 34).

Towards the bottom, in the Dan River coal field, N. C.:

Cheirolepis Münsteri, Schimper (?) (Font., Mon. vi, p. 99).
Belodon Leaii, Emm., (Cope, N. C. Geol. Rep., 1875, App., p. 35).
Estheria ovata, Lea (T. R. Jones, Geol. Mag., vii, 1890, p. 387).

Towards the bottom, in North Carolina:

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 98).
Sphenozamites Rogersianus, Font. (do., p. 98).

Towards the bottom (?), in Moore county, N. C.:

Belodon Caroliniensis, Emm. (Cope, N. C. Rep., 1875, App., p. 34).
Belodon priscus, Leidy (do., p. 34).

Towards the bottom (?), in Montgomery county, N. C.:

Belodon priscus, Leidy (Cope, N. C. Rep., 1875, App., p. 34).

Towards the bottom (?), in Anson county, N. C.:

Belodon Caroliniensis, Emm. (Cope, N. C. Rep., 1875, App., p. 34).

Towards the bottom, at Clover Hill, Va.:

Schizoneura planicostata, Rogers (Font., Mon. vi, p. 16).
Schizoneura (?), (1 specimen) (do., p. 16).
" Virginiensis, Font. (do., p. 18).
Macrotoeniopteris crassinervis, Feist (do., p. 23).
Acrostichides rhombifolius, Font. (do., p. 32).
Acrostichides rhombifolius, var. rarinervis, Font. (do., p. 33).
Acrostichides microphyllus, Font. (do., p. 34).
Acrostichides densifolius, Font. (do., p. 34).
Mertensides distomus, Font. (do., p. 40).
Asterocarpus Virginiensis, Font. (do., p. 45).
" " var. obtusiloba, Font. (do., p. 46).
Asterocarpus platyrachis, Font. (do., p. 47).
" penticarpa, Font. (do., p. 48).
Cladophlebis ovata, Font. (do., p. 51).

Cladophlebis microphylla, Font. (do., p. 52).
Cladophlebis pseudowhitbiensis, Font (do, p. 52).
Lonchopteris Virginiensis, Font. (do., p. 54).
Clathropteris platyphylla, var. expansa, Saporta, (do., p. 58).
Pseudodanæopsis reticulata, Font. (do., p. 60).
Pseudodanæopsis nervosa, Font. (do., p. 63).
Sagenopteris rhoifolia (?), (do., p. 63).
Dicranopteris, spec. (?), (do., p. 63).
Pterophyllum inæquale, Font. (do., p. 65).
Ctenophyllum truncatum, Font. (do., p. 69).
Ctenophyllum grandifolium, Font. (do, p. 76).
Ctenophyllum giganteum, Font. (do., p. 77).
Podozamites Emmonsi, Font. (do., p. 78).
" tenuistriatus, Rog. (do, p. 79).
Sphenozamites Rogersianus, Font. (do., p. 84).
Baiera multifida, Font. (do., p. 88).
Undetermined cones (do., p. 91).

Towards the bottom, at Midlothian, Va.:

Asterocarpus Virginiensis, Font. (Font., Mon. vi, p. 45).
Pseudodanæopsis reticulata, Font. (do., p. 60).
Pterophyllum affine, Nathorst (do., p. 66).
Ctenophyllum taxinum, L. and H. (do, p. 68).
Podozamites tenuistriatus, Rogers (do., p. 79).

Towards the bottom, at Gowry shaft, near Midlothian, Va.:

Acrostichides limnææfolius, Bunb. (Font., Mon. vi, p. 28).
Acrostichides rhombifolius, Font. (do., p. 32).
Mertensides bullatus, Bunb. (do., p. 39).
Zamiostrobus Virginiensis, Font (do., p. 85).

Towards the bottom, at Black Heath, Va.:

Acrostichides linnææfolius, Bunb. (Font., Mon. vi, p. 28).

Towards the bottom, at Aspinwall shaft, at Manakin, near Dover, Va.:

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 11).
Asterocarpus Virginiensis, Font. (do., p. 45).
Pecopteris rarinervis, Font. (do., p. 49).
Cladophlebis subfalcata, Font. (do., p. 49).
Lonchopteris Virginiensis, Font. (do., p. 51).

Towards the bottom, at Carbon Hill, Va.:

Schizoneura planicostata, Rog. (Font., Mon. vi, p. 16).
Acrostichides rhombifolius, Font. (do., p. 32).
Mertensides bullatus, Bunb. (do., p. 39).
Asterocarpus Virginiensis, Font. (do., p. 45).
Pecopteris rarinervis, Font. (do., p. 49).
Cladophlebis auriculata, Font. (do., p. 50).
Pseudodanæopsis reticulata, Font. (do., p. 60).
Ctenophyllum Braunianum, var. α, Goepp. (do., p. 73).
Podozamites tenuistriatus, Rog. (do., p. 79).
Baiera multifida, Font. (do., p. 88).

Towards the bottom, at Deep Run, Va.:

Podozamites tenuistriatus, Rog. (Font., Mon. vi, p. 79).

Towards the bottom, in the Richmond basin, Va.;

Catopterus gracilis, J. H. R. (Newb., Mon. xiv, p. 11).
Dictyopyge macrura, Egt. (do., p. 11).
Ischypterus ovatus W. C. R. (do., p. 11).

Towards the bottom, in the Farmville, Cumberland county, Va., area:

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 12).
Pterophyllum decussatum, Emmons (do., p. 67).
Podozamites tenuistriatus, Rog. (do., p. 79).
Cheirolepis Münsteri, Schimper (do., p. 89).
Bambusium (?) (do., p. 90).

Towards the bottom, in the Hanover county, Va., area :

Equisetum Rogersi, Schimper (Font., Mon. vi, p. 12)
Macrotaeniopteris magnifolia, Schimper (do., p. 20).
Cladophlebis rotundiloba, Font. (do., p. 53).
Cycadites tenuinervis, Font. (do., p. 84).

Near the bottom, near Durham, Conn.:

Baiera Münsteriana, Ung. (Newb., Mon. xiv, p. 84).
Schizoneura planicostata, Rogers (do., p. 87).
Pachyphyllum brevifolium, Newb. (Newb., Mon xiv, p. 89).
Otozamites latior, Saporta (do., p. 90).
" brevifolius, T. Br. (do., p. 91).
Cycadiocarpus Chapini, Newb. (do., p. 92).
Loperia simplex, Newb. (do., p. 93).
Clathropteris platyphylla, Brong. (do., p. 94).
Ischypterus micropterus, Newb. (do., p. 32).
Ischypterus tenuiceps, Ag. (do., p. 34).
" minutus, Newb. (do., p. 48).
Catopterus Redfieldi, Egerton (do., p. 53).
" gracilis, J. H. R. (do., p. 55).
" minor, Newb. (do., p. 57).
" ornatus, Newb. (do., Pl. xviii).
" anguilliformis, W. C. R. (do., p. 60).
Ptycholepis Marshii, Newb. (do., p. 67).
Diplurus longicaudatus, Newb. (do., p. 74).

Near the bottom, at Middlefield, Conn.:

Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).
Ischypterus fultus, Ag. (do., p. 34).
Brontozoum giganteum, E. H. (Suppl. Ichn., p. 24).
Plesiornis æqualipes, E. H. (Ichn., p. 105).
Typopus gracilis, E. H. (do., p. 106).

Near the bottom, at Middletown (west of the village), Conn.:

Fucoid, undetermined (Hitchc., 1841, p. 453).
Catopterus gracilis, J. H. R. (Newb., Mon. xiv, p. 35).
Catopterus anguilliformis, W. C. R. (?) (do., p. 59).
Anisopus Deweyanus, E. H. (Ich., p. 61).
" gracilis, E. H. (do., p. 62).
Chimaera Barratti, E. H. (?) (do , p. 119).
Cunicularius retrahens, E. H. (do., p. 163).

Near the bottom, at Westfield, Conn.:

Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).
Ischypterus fultus, Ag. (do., p. 34).
Ischypterus parvus, W. C. R. (?) (do., p. 45).
Catopterus anguilliformis, W. C. R. (?) (do., p. 59).

Near the bottom, at the Cove, in Wethersfield, Conn.:

Fucoid, undetermined (see Hitchcock, Mass. Geol. Rep., 1841, p. 450).
Plants, undetermined (do., p. 451).
Coprolites (?) (do., p. 461).
Brontozoum giganteum, E. H. (Suppl., p. 24).
Brontozoum minusculum, E. H. (do., p. 24).
Brontozoum divaricatum, E. H. (C. H. H., Bost. Nat. Hist. Soc., xxiv, p. 121).
Brontozoum Sillimanium, E. H. (do., p. 121).
Argozoum disparidigitatum, E. H. (Ich., p. 82).
Argozoum paridigitatum, E. H. (do., p. 82).
Grallator cuneatus (C. H. H., Bost. N. H. S., xxiv, p. 121).
Grallator tenuis (do., p. 121).
Corvipes lacertoideus, E. H. (do., p. 122).
Anomoepus curvatus (do., p. 121).
Platypterna Deaniana, E. H. (Ich., p. 83).
" tenuis, E H. (do., p. 84).
" delicatula, E. H. (do., p. 84).
Ornithopus gallinaceus, E. H. (do., p. 87).
" gracilior, E. H. (do., p. 88).
Tridentipes insignis, E. H. (do., p 91).
Plectropterna minitans (do., p. 109).
" elegans, E. H. (C. H. H., B. N. H. S., xxiv, p. 122).
Plectropterna gracilis, E. H. (do., p. 122).
Pletropterua lineans, E. H. (Suppl., p. 71).
Plesiornis giganteus, C. H. H. (B. N. H. S., xxiv, p. 122).
Plesiornis æqualipes, E. H. (do., p. 122).
" n. sp. (do , p. 122).
Trihamus elegans, E. H. (do., p. 122).

Trihamus magnus, C. H. H. (do., p. 122).
Triænopus leptodactylus, E. H. (Ichn., p. 111).
Harpedactylus, n. sp. (C. H. H., B. N. H. S., xxiv, p. 122).
Typopus abnormis, E. H. (do., p. 122).
Comptichnus, n. sp. (do., p. 122).
Ancyropus heteroclitus, E. H. (Ich., p. 139).
Acanthichnus cursorius, E. H. (do., p. 139).
Acanthichnus cursorius var. trilinearis, E. H. (do., p. 139).
Acanthichnus cursorius var. alatus, E. H. (do., p. 139).
Conopsoides larvalis, E. H. (Ich., p. 152).
Unisulcus minutus (C. H. H., B. N. H. S., xxiv, p. 122).
Bisulcus (do., p. 122).
Trisulcus (do., p. 122).
Cochlichnus, 2 sp. (do., p. 122).
Sagittarius and other footmarks (do., p. 122).

Near the bottom, at Mittineaque Falls, in West Springfield, Mass.:

Footmarks (Hitchcock, Mass. Geol. Rep., 1841, p. 466).

Near the bottom, at West Springfield, Mass.:

Coprolite (?) (Hitchcock, Mass. Geol. Rep., 1841, p. 461).

Near the bottom, in southeastern Northampton, Mass.:

Anisopus gracilis, E. H. (Ich., p. 62).
Brontozoum minusculum, E. H. (do, p. 66).
Brontozoum exsertum, E. H. (do, p. 67).
" validum, E. H. (do, p. 68).
" Sillimanium, E. H. (do., p. 69).
Brontozoum isodactylum, E. H (do., p. 70).
Brontozoum giganteum, E. H. (Sup., p. 24).
" approximatum, E. H. (do., p. 24).
Tridentipes ingens, E. H. (Ich, p. 89).
" insignis, E. H. (do., p. 91).
Palamopus Clarki, E. H. (do., p. 127).

Near the bottom, in South Hadley, Mass.:

Anisopus gracilis, E. H. (Ich., p. 62).
Brontozoum Sillimanium, E. H. (do., p. 69).
" isodactylum, E. H. (do., p. 70).
Grallator cursorius, E. H. (do., p. 73).
Grallator tenuis, E. H. (do., p. 73).
" gracillimus, E. H. (do., p. 74).
Batrachoides nidificans, E. H. (do., p. 123).

Near the bottom, in the north part of South Hadley, Mass.:

Anisopus Deweyanus, E. H. (Sup., p. 45).
Brontozoum giganteum, E. H. (Sup., p. 24).
Grallator cuneatus, E. H. (Ich., p. 75).
Batrachoides nidificans (do, p. 123).
Otozoum Moodii, E. H. (do., p. 125).

Near the bottom, at Whitmore's Ferry, in Sunderland, Mass.:

Plants (Hitchc., Mass. Geol. Rep., 1841, p. 450).
Fishes (do., p. 458).
Schizoneura planicostata, Rog. (Newb., Mon. xiv, p. 12).
Clathropteris platyphylla, Brong. (do., p. 94).
Pachyphyllum simile, Newb. (do., p. xxii).
Ischypterus ovatus, W. C. R. (do., p. 27).
" Marshii, W. C. R. (do., p. 29).
" Agassizii, W. C. R. (do., p. 30).
" parvus, W. C. R. (do, p. 45).
" latus, J. H. R. (do, p. 46).
" tenuiceps, Ag. (do., Pl. v, vii).

Near the bottom, at Marsh's quarry, in the southwest part of Montague, Mass.:

Anticheiropus pilulatus, E. H. (Sup., p. 10).
Tridentipes elegans, E. H. (do., p. 90).
Tridentipes insignis, E. H. (do., p. 91).
Chimæra Baratti, E. H. (?) (do., p. 119).

Near the bottom, at two miles south of Turner's Falls, in Montague, Mass.:

Tridentipes elegans, E. H. (Ich., p. 90).

Near the bottom, in Montague, Mass:

Clathropteris, obscure (Font., Mon. vi, p. 58).

Near the bottom, in the north part of Montague, Mass.:

Tridentipes elegans, E. H. (Ich., p. 90).

Near the bottom, at the Horse Race, in Gill, Mass.:

Brontozoum giganteum, E. H. (Sup., p. 24).
" approximatum, E. H. (do., p. 24).
Argozoum paridigitatum, E. H. (Ich., p. 82).
Ornithopus gallinaceus, E H. (do., p. 87).
Tridentipes ingens, E. H. (do., p. 89).
" elegans, E. H. (do., p. 90).
" insignis, E. H. (do., p. 91).
Hoplichnus equus (do., p. 35).

Near the bottom, in Gill, Mass.:

Dictyophyllum, or Camptopteris (Font., Mon. vi, p. 58).

Somewhere near the bottom, at Springfield, Mass.:

Anchisaurus polyzelus (Hitchcock, Supp. Ichn., 1865, p. 39; and Marsh, Am. Jour. Sci, xxxvii, p. 332, 1889).
Coprolite (?) (Hitchc., Mass. Geol. Rep., 1841, p. 461).

Somewhere near the bottom, one mile south of Chicopee, on the road to Springfield, Mass.:

Ancyropus (Sauroidichnites) heteroclitus, E. H. (1841, p. 479).
Plectropterna (Sauroidichnites) minitans, E. H. (1841, p. 482).
Polemarchus gigas, E. H. (Ich., p. 108).

Somewhere near the bottom, at Chicopee, Mass.:

Plant resembling Lemania (Hitchc., Rep., 1841, p. 450).

Somewhere near the bottom, at South Hadley Falls, Mass.:

Plant, undetermined (Hitchc., Mass. Rep., 1841, p. 452).
Harpagopus dubius, E. H. (?) (Ich., p. 148).
Fishes (Newb., Mon. xiv, p. 21).

Towards the bottom, at Chicopee Falls, Mass.:

Plant, perhaps a Fucoid (Hitchc., Mass. Rep., 1841, p. 453).
Footmarks (do., p. 466).
Pycnodont fish tooth (do., p. 460).
Acentrophorus Chicopensis, Newb. (Newb., Mon. xiv, p. 70).
Argozoum Redfieldianum, E. H. (Ich., p. 82).
Argozoum disparidigitatum, E. H. (Ich., p. 82).
Ornithopus gallinaceus, E. H. (do., p. 87).
Polemarchus gigas, E. H. (do, p. 108).

Towards the bottom, at Ellingtons, N. C.:

Laccopteris Münsteri, Schenk (Font., Mon. vi, p. 102).
Laccopteris elegans, Presl. (do., p. 102).
Lonchopteris oblongus, Emmons (do., p. 103).
Sagenopteris rhoifolia (do., p, 104).
Acrostichides rhombifolius, Font. (do., p. 105).
Palissya diffusa, Emmons (do., p. 107).
Cheirolepis Münsteri, Schimper (do., p. 108).
Equisetum Rogersi, Schimper (do., p. 109).
Podozamites Emmonsi, Font. (do., p. 111).
Pterophyllum decussatum, Emmons (do., p 111).
Pseudodanæopsis reticulata, Font. (do., p. 116).
Ctenophyllum, type of imbricatum (do., p. 116).

Below the middle, at Klinesville, N. J.:

Lamellibranch, undetermined (N. J. Geol. Rep., 1888, p. 29).
Cypris (do., p. 30).
Estheria (do., p. 30).

Near the middle, at Manchester, Conn.:

Anchisaurus major, Marsh (Am. Jour. Sci., 1889, xxxvii, p. 331).

About the middle, at Haywood, N. C.:

Cladophlebis obtusiloba, Andrae (?) (Font., Mon. vi, p. 105).
Ctenophyllum Braunianum, var. β, Goepp. (do., p. 112).

Perhaps about the middle, at five miles north of Haywood, N. C.:

Baiera multifida, Font. (Font., Mon. vi, p. 118).

Perhaps about the middle, at House's quarry, on the Haw river, N. C.:

Ctenophyllum Emmonsi, Font. (Font., Mon. vi, p. 113).
Ctenophyllum lineare, Font. (do., p. 114).
Pterophyllum spatulatum, Font. (do., p. 114).
Zamiostrobus Emmonsi, Font. (?) (do, p. 117).

At about 1500 feet below the top, at the south entrance of the Reading railroad tunnel, near Phœnixville, Pa.:

Plants (H. C. Lewis, Science, 1884, Vol. iii, p. 295).
Unio, 2 species (do., p. 295).
Marine lamellibranchs, 3 species (do., p. 295).
Ganoid fish (do., p. 295).
Saurian (?) (do., p. 295).

At about 1000 feet below the top, in the Reading railroad tunnel, near Phœnixville, Pa.:

Estheria Hindei, T. Rup. Jones (Geol. Mag., 1891, viii, p. 51).
Estheria Lewisii, T. Rup. Jones, "Red S. S. of Bucks county, Pa." (do., 1890, vii, p. 385).
Ganoid fishes (Leidy, A. N. S. Proc., 1859, Apr. 5).
Clepsysaurus (?) teeth (do., do.). (These are Belodon teeth, according to Cope.)
Eurydorus serridens (do., do.).
Compsosaurus (?) (do., do.).
Eupelor durus (Cope, do, 1866, p. 249, and A. P. S. Trans., 1868, xiv, p. 25).
Belodon Caroliniensis, Emm. (Cope, A. P. S. Proc., 1886, xxiii, p. 403).
Belodon lepturus, Cope (A. P. S. Trans., 1868, xiv, p. 59).
Rhabdopelix longispinis, Cope (?) (do., p. 174).
Dicynodon rosmarinus (do., 232).
Batrachian tracks (Cope, do., p. 242).
Coprolites (Wheatley, A. N. S. Proc, 1859, p. 110).
Limulus (?) (do., p. 110).
Equisetum columnare, Brg. (do., p. 110).
Pterozamites longifolius, Emm. (do., p. 110).
Gymnocaulus alternatus, Emm. (do., p. 110).
Fir Cones (Lea, A. J. S., 1856, xxii, p. 123).
Calamites punctata (do., p. 123).
Dictyocaulus striatus (do., p. 123).
Estheria ovata, Lea (Wheatley, A. N. S. Proc., 1861, Vol xxxii, p. 43).
Estheria parva, Lea (do., p. 43).
Cypris, 2 species (do, p. 43).
Myacites Pennsylvanicus, Conrad (A. N. S. Proc., 1857, p. 86).
Radiolepis speciosus, Emm. (Lea, do., 1857, July 7).
Centemodon sulcatus, Lea (do., 1856, Mar., p. 77).
Chelichnus Wymanianus, Lea (do., p. 77).
Catopterus gracilis, Redf. (Wheatley, A. J. S., 1861, p. 41).

At about 1000 feet below the top, near Yerkes Station, Montgomery county, Pa.:

Radiolepis elegans Emm. (Leidy, A. N. S. Proc., 1876, May 9, p. 81).

At about 1000 feet below the top, at the Gwynedd tunnel, Montgomery county, Pa.:

Cypris (Leidy, Ac. Nat. Sci. Proc., 1857, June 16).
Batrachian (?) bones and teeth (do., do.).
Radiolepis speciosus, Emm. (Lea, do., 1857, July 7).
Eurydorus serridens (?) (Leidy, do., 1859, Apr. 5).
Rhabdopelix longispinis, Cope (A. P. S. Trans., 1868, xiv, p. 174).
Turseodus acutus, Leidy (A. N. S. Proc., 1857, June, p. 167).

Towards the top, "2000 feet or more above the coal measures," at Lockville, Chatham county, N. C.:

Sagenopteris rhoifolia (Font., Mon. xiv, p. 104).
Palissya Braunii, Endl. (do., p. 107).
Cheirolepis Münsteri, Schimper (do., p. 108).
Cycadites Roemeri, Schenk (?) (do., p. 109).
Cycadites longifolius, Emm. (?) (do., p. 110).
Pterophyllum pectinatum, Emm. (do., p. 112).
Zamiostrobus Emmonsi, Font. (?) (do., p. 117).
Otozamites Carolinensis, Font. (do., p. 117).
Araucaria (?) (do., p. 118).
Araucarites Carolinensis, Font. (do., p. 119).

Towards the top, at Ketch's mills, in the east part of East Windsor, Conn.:

Bones, undetermined (Hitchc., Mass. Geol. Rep., 1841, p. 503).

Towards the top, at Ellington (Ct.):

Bones, undetermined (Hitchc., Mass. Geol. Rep., 1841, p. 504).

Perhaps towards the top, at Amherst, Mass.:

Fishes (Newb., Mon. xiv, p. 21).

Towards the top, at Washington's Crossing, N. J.:

Estheria (N. J. Geol. Rep., 1888, p. 30).
Fishes (do., p. 30).

Very near the top, at Tumble Station, N. J.:

Footmarks (Nason, N. J. Geol. Rep., 1888, p. 29).

LANSDALE SHALES.

Towards the bottom, at Little Falls and Pleasantdale, N. J.:

Plants, abundant (Nason, N. J. Geol. Rep., 1888, p. 23).

Towards the bottom, near Feltville, N. J.:

Cypris (?) (Nason, N. J. Geol. Rep., 1888, p. 22).

Towards the bottom, at Fields' copper mine, near Warrenville, and near Plainfield, N. J.:

Estheria (Nason, N. J. Geol. Rep., 1888, p. 30).
Fishes (do., pp. 29, 30).

Towards the bottom, near Washingtonville, N. J.:

Plants (Nason, N. J. Geol. Rep., 1888, p. 27).

Towards the bottom, near Martinsville, N. J.:

Tree trunks and ferns (Nason, N. J. Geol. Rep., 1888, p. 27).

Towards the bottom, near Pluckamin, N. J.:

Plants (Nason, N. J. Geol. Rep., 1888, p. 23).

About the middle, near New Providence, N. J.:

Plants (Nason, N. J. Geol. Rep., 1888, p. 28).

About the middle, near Whitehall, N. J.:

Tridentipes ingens, E. H. (C. H. H., Bost. Soc. N. Hist., xxiv, p. 122).
Brontozoum giganteum, C. H. H. (do., p. 122).
Brontozoum minusculum, E. H. (do., p. 122).
Brontozoum Sillimanium, E. H. (do., p. 122).
Grallator formosus, E. H. (do., p. 122).
Grallator parallelus, E. H. (do., p. 122).
" cursorius, E. H. (do., p. 122).
Anomœpus intermedius, E. H. (do., p. 122).

Apatichnus crassus, C. H. H. (do., p. 122).
Anisichnus gracilis, E. H. (do., p. 122).
Brontozoum isodactylum (Cook, N. J. Geol. Rep., 1885, p. 96).
Brontozoum divaricatum, E. H. (do., p. 96).

Towards the top, at Pompton furnace, N. J.:

Ischypterus Agassizii, W. C. R. (Newb., Mon. xiv, p. 30).

Perhaps towards the bottom, one mile south of Goldsboro, York county, Pa.:

Ramulus rugosus, Wanner (A. Wanner, Pa. Geol. Rep., 1887, p. 27).
Algæ (do., p. 21.)
Anomœpus gracillimus, C. H. H. (Bost. Nat Hist. Proc., xxiv, p. 123).
Brontozoum Sillimanium, E. H. (do., p. 123).
Anisichnus gracilis, E. H. (do., p. 123).

Perkasie Shales.

Near the bottom, at Smith Clark's quarry, near Milford, N. J.:

Palæophycus limaciformis, H. C. Lewis (A. N. S. Proc., Nov., 1880, p. 93).
Schizoneura planicostata, Rog. (Newb., Mon. xiv, p. 11).
Equisetum Rogersi, Schimper (do., p. 85).
Cheirolepis Münsteri, Schimper (do., p. 89).
Clathropteris platyphylla, Brg. (do., p. 94).
Grallator parallelus, E. H. (C. H. H., Bost. Nat. Hist. Soc., xxiv, p. 122).
Grallator cuneatus, Barratt (do., p. 122).
" gracilis, C. H. H. (do., 122).
Chimærichnus ingens, C. H. H. (do., p. 122).
Polemarchus gigas, E. H. (do., p. 122).
Argozoum disparidigitatum, E. H. (do., p. 122).
Otozoum parvum, C. H. H. (do., p. 122).
Unisulcus magnus, C. H. H. (do., p. 122).
Sagittarius (do., p. 122).
Brontozoum isodactylum, E. H. (Eyerman, Ac. Nat. Sci. Proc., 1889, p. 32).
Grallator tenuis, E. H. (do., p. 32).
Anomœpus minor, E. H. (do., p. 32).
Harpagopus dubius, E. H. (do., p. 32).
Unisulcus marshi, E. H. (do., p. 32).
" minutus, E. H. (do., p. 32).

Near the bottom, at Boonton, N. J.:

Ischypterus ovatus, W. C. R. (Newb., Mon. xiv, p. 27).
Ischypterus Agassizii, W. C. R. (do., p. 30).
" tenuiceps, Ag. (do., p. 34).
" fultus, Ag. (do., p. 31).
" robustus, Newb. (do., p. 37).
" elegans, Newb. (do., p. 37).
" alatus, Newb (do., p. 38).
" modestus, Newb. (do., p. 39).
" lenticularis, Newb. (do., p. 39).
" lineatus, Newb. (do., p. 41).
Ischypterus macropterus, W. C. R. (do., Pl. xii).
Ischypterus parvus, W. C. R. (?) (do., p. 45).
Ischypterus gigas, Newb. (do., Pl. xiv).
Catopterus parvulus, W. C. R. (do., p 61).
" gracilis, J. H. R. (do., p. 55).
Diplurus longicaudatus, Newb. (do., p. 74).
Brontozoum approximatum, C. H. H. (Bost. Nat. Hist. Soc., xxiv, p. 123).
Grallator formosus, E. H. (do., p. 123).

Towards the bottom, at New Vernon, N. J.:

Footmarks, imperfect (Cook, N. J. Geol. Rep., 1885, p. 95).

Norristown Shales.

About 5000 feet above the bottom, in Upper Milford township, Lehigh county, Pa.:

Clepsysaurus Pennsylvanicus, Lea (Lea, A. N. S. Jour., 1883, p. 185).

These lists probably show satisfactorily that there is no serious paleontological obstacle to accepting the views here set forth in regard to the New Red; certainly none to compare in seriousness with the obstacles that were boldly overridden repeatedly in making the Portland and Newark fossils Triassic.

Although the account just given puts quite another face upon the New Red with the unquestionably great thickness in Pennsylvania, and the partly conjectural, but quite harmoniously corresponding, condition of the beds in other States, yet it is clear that what is most extraordinary about the present views, so far as they are speculative, is that, for New Red speculations, they are so little extraordinary, so free from extravagance, so natural, probable and simple, yet so fully capable of explaining all the observed facts. It is seen that, although the New Red beds do not everywhere exist in the same completeness as in Montgomery county, yet that certain portions are pretty fully represented in distant States, the lower third in Connecticut, the lower half in Northeastern New Jersey, and the lower portions and upper portions in separate basins in Virginia. It is further plain that almost all, if not quite all, the fossils from which the Rhaetic, or Triassic, or Jurassic age of our New Red has been inferred, come from the Gwynedd shales alone; and that the few fossils from other parts of the whole New Red series have either been useless as indications of age or have been flatly disregarded. Hence it is not improbable that the Norristown shales, with the great calamite near Doylestown, the apparent Lepidodendron at Newark and Belleville, and the Palæophycus at Portland, may after all prove to be at least as old as the Permian. It seems, indeed, highly probable that the well-ascertained great thickness of 27,000 feet in Montgomery county should represent more than one limited paleontological period, and not only that it should include the Permian, but that the very extensive upper third of that space, hitherto almost devoid of reported fossils, should turn out to be much newer than the Triassic. Those upper beds have also shown here and there imperfect fossil traces, and as there are occasional beds of green shales among the predominant red ones, there is reason to hope that more abundant and perfect fossils may some day be found.

As for the trap, it seems impossible to doubt any longer that all the conformable trap sheets are overflows contemporaneous with the sedimentary beds, and not subsequent intrusions.

It is furthermore at any rate evident that thoroughly geological methods, as distinguished from purely paleontological ones, are of great importance in working out the geology, that is, the structure, the cross-sections, the columnar section and the outcrops of any region, but especially of one where fossils are scarce; and that the topography is extremely useful as an aid to understanding the geology.

PROC. AMER. PHILOS. SOC. XXXIII. 145. 2 B. PRINTED JUNE 16, 1894.

ERRATA.

Please insert the two following lists of fossils at the first break on page 209:

Towards the bottom, about two miles north of west of Emigsville, York County, Pa.:

Belodon Priscus, Leidy (Cope, A. P. S. Proc., 1886, Vol. xxiii, p. 403).
Belodon Carolinensis, Emmons (do., p. 403).
Palæosaurus Fraserianus, Cope (do., p. 404).
Suchoprion cyphodon, Cope (do., p. 404).
" aulacodus, Cope (do., p. 404).
Clepsysaurus Veatleianus, Cope (do., p. 404.)
Palæoctonus appalachianus, Cope (do., p. 404).
Thecodontosaurus gibbidens, Cope (do., p. 404).

Towards the bottom, four miles "eastward" from the Goldsboro fossil footprints, York Co., Pa.:

Ramulus rugosus, Wanner (Pa. Geol. Rep., 1887, p. 27).

On page 212, eight lines from the top, instead of "Reading" read *Pennsylvania.*

On page 214, seven lines from the top, instead of "bottom" read *top.*